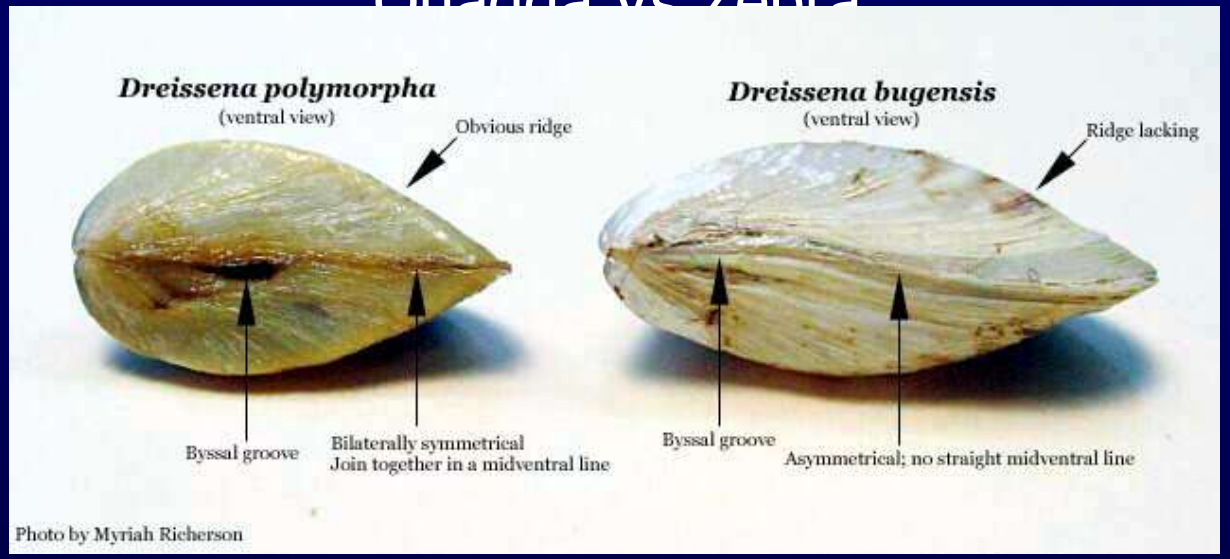
Quagga Mussels: An Introduction to *Dreissena bugensis*

ENTRIX

MORPHOLOGY

Quagga Vs Zebra



MOLECULAR GENETICS

ALLOZYMES

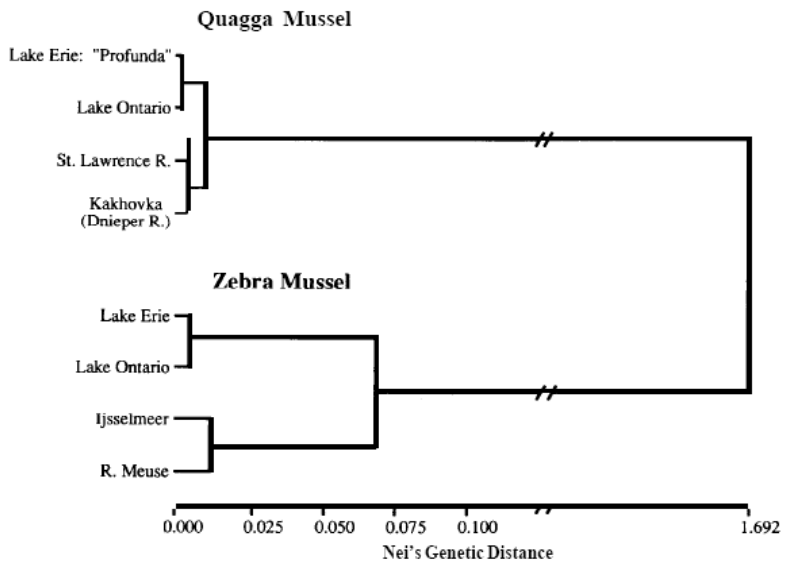


FIG. 2: UPGMA dendrogram of Nei's genetic distances between North American and European populations of zebra and quagga mussels based on 11 loci.

DNA Sequencing

Sequence difference between zebra and quagga mussels at Cytochrome c oxidase subunit I mitochondrial gene

*SPERM MORPHOLOGY

Quagga Vs Zebra

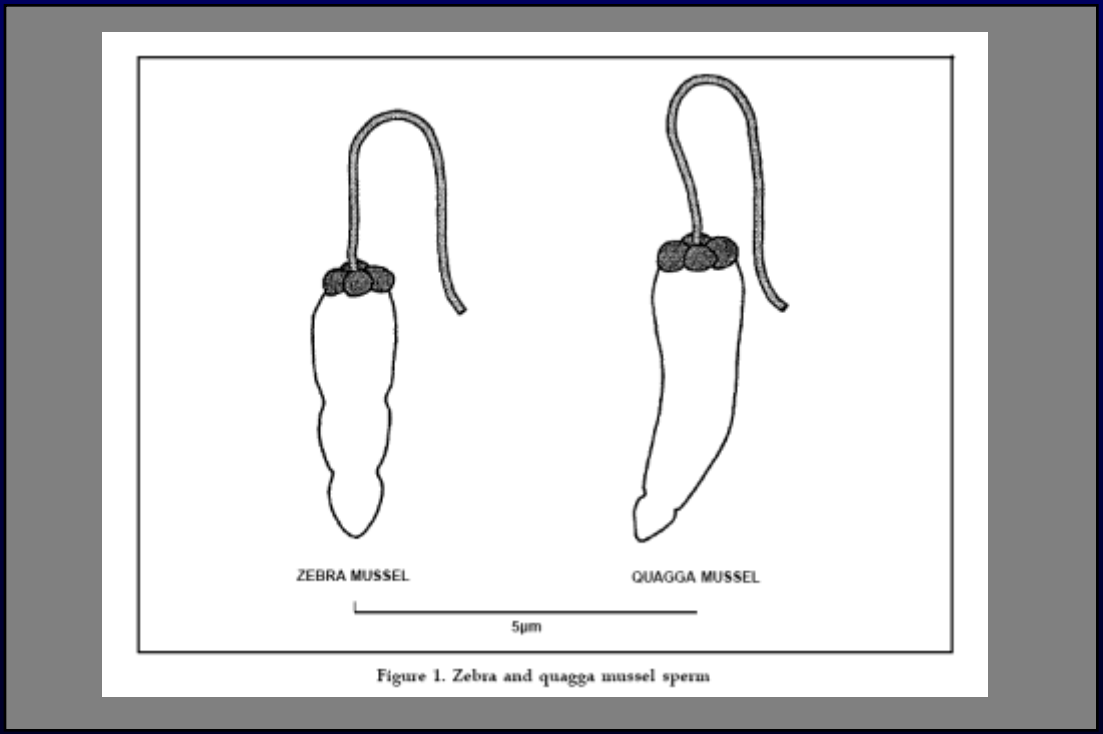


Figure 1. Zebra and quagga mussel sperm

ACOE 1994

*Not actual size

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REPRODUCTION

- Dioecious (either male or female)
- Spawn late May –June (7-9^{o}C) (Zebra = 10-12^{o}C)
- Female mussel - up to one million eggs per season

Post Fertilization

- Veligers (pelagic larvae) develop bivalve shells
- Free-swimming – drift with currents – 4 weeks
- Feed using cilia
- Locate suitable substrate and attach

- Lifespan – 1.5-2 Years

REPRODUCTION
Hybridization

- Hybridization with zebra mussels is a concern
- Zebra x quagga mussles hybrids were created in laboratory

But…

- Anticipated that they may be a small portion of the dreissenid community
- Evidence for species-specific sperm attractants suggesting that interspecific fertilization may be rare in nature
- Timing may limit cross-fertilization opportunities

FEEDING

- Filter feeders
- Use cilia to pull water into their shell cavity
- Water/Food passes through the incurrent siphon and particulates are removed
  - Phytoplankton
  - Zooplankton
  - Algae
  - Quagga mussel veligers (cannibals)
- Undesirable particulates are bound with mucus or “pseudofeces” and ejected out through th excurrent siphon

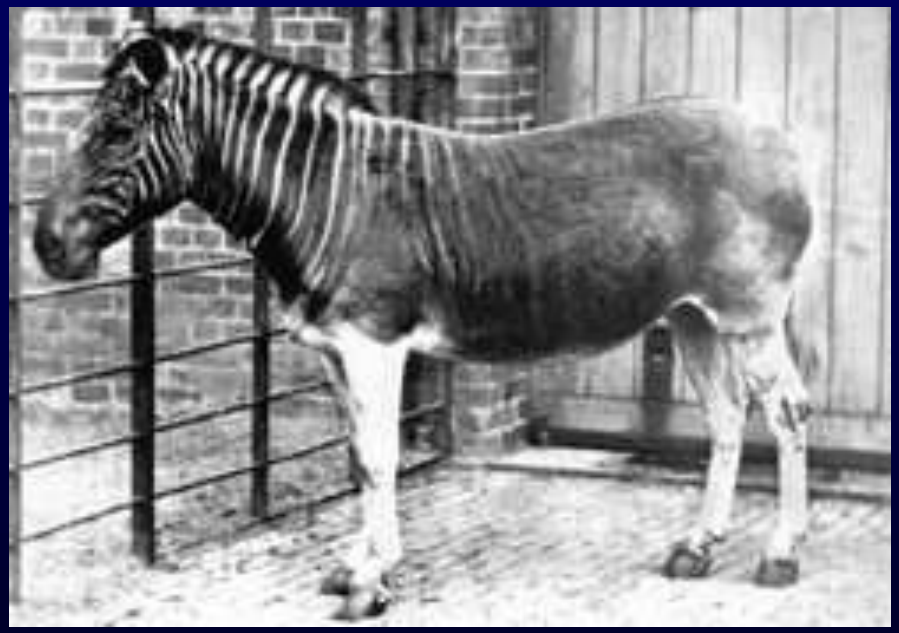
ORIGIN

- Indigenous to Dneiper River drainage of Ukraine
- Discovered in the Bug River in 1890 by Andrusov (hence "*bugensis*")

- Canals allowed range expansion
- Occurs now in almost all Dneiper reservoirs in eastern and southern regions of Ukraine and deltas of Dnieper River
- Named "quagga mussel" after the "quagga" an extinct African relative of the zebra

QUAGGA

Equus quagga



INVASION

Introduction
- Introduced into the Great Lakes via ballast water discharge - 1989
- Outside the Great Lakes - 1995
- Lake Mead - 2007

Movement
- Larval drift in rivers
- Overland transport

Risk
- Highly polymorphic
- Prolific
- High potential for rapid adaptation

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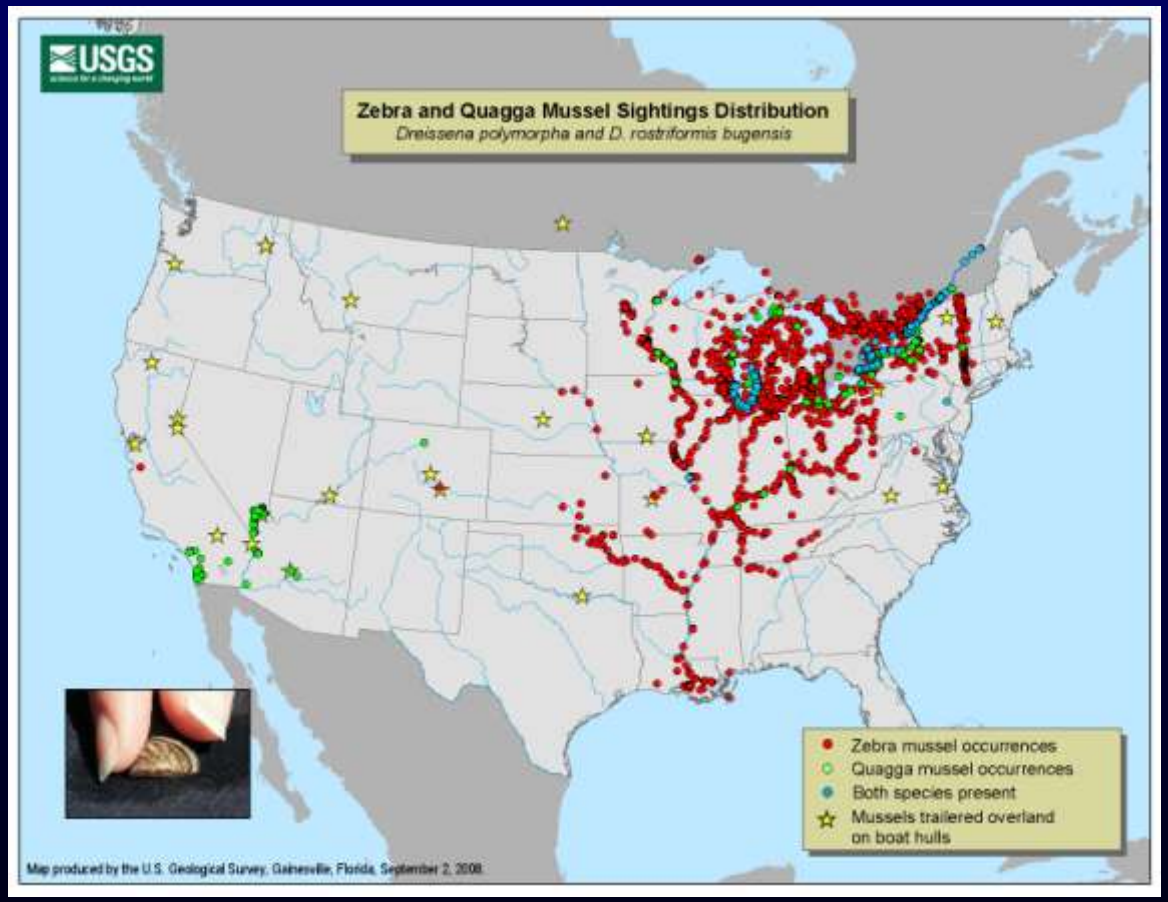
CURRENT DISTRIBUTION



ECOLOGICAL IMPACT

- Prodigious water filterers – remove phytoplankton and suspended particulates
- Removal of phytoplankton – decrease food source for zooplankton – alteration of food web
- Water Filtration
  - Increased transparency
  - Increased light penetration
  - Increases/Changes in aquatic plant composition
  - Decreased chlorophyll a concentrations

- Accumulation of pseudofeces
  - Waste particles decompose – oxygen is used up, pH becomes acidic, toxic byproducts are produced
  - Bioaccumulation of pollutants passed through pseudofeces into food chain

ECONOMIC IMPACT

NOAA PHOTO

This electrical conductor hauled out of Lake Michigan was rendered inoperable by an infestation of zebra mussels. The invasive species, which has no natural enemies in North America, was recently found in Pueblo Reservoir on the Front Range.

Industrial

Clog water intake structures e.g. pipes, screens

Reduces pumping capabilities for power and water treatment plants

Recreational and Cultural

Colonization of docks, breakwalls, buoys, boats, and beaches

Encrusting submerged cultural resources

Littering beaches with sharp shells, decomposing mussels - odor

Ecosystem

Ability to colonize both hard and soft substrata – will impact native freshwater mussels, invertebrates – fisheries etc.

CONTROL
Chemical

Chemical toxicant for lake-wide control has not been developed (lethality to other aquatic life)

- Prechlorination most common control treatment – concern over level (hazardous)
- Potassium permanganate – mostly for drinking water sources
- Radiation
- Organic molluscicides
- Copper-ion generation

CONTROL
Physical

- Oxygen deprivation
- Thermal treatment
- Exposure and dessication
- Manual scraping
- High pressure jetting
- Mechanical filtration
- Removable substrates
- Ozone
- Anti-fouling coatings
- Electrical currents
- Sonic vibration
- Building piping at low depths (quagga mussels grow at deeper depths than zebra mussels – therefore less of an option)

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CONTROL
Biological

Ineffective so far

- Predation by migrating diving ducks, fish, crayfish
- Toxic microbes
- Parasites
- Disruption of reproductive process (e.g. interfering with male/female synchronization)
- Inhibition of veliger settling
- Desiccation

RISK
RELATIVE TO ZEBRA

- Quagga
  - Occupy deeper depths
  - Tolerate lower temperatures
  - More prolific
  - Lower metabolic demands
  - Thinner shells

NOTE - Between 2000 and 2005 almost a complete change in dominance from zebra to quagga in Lake Michigan

RISK
LIMITING FACTORS

SALINITY
Tolerant up to 5ppt (4 = max found in nature)

TEMPERATURE
Mortality at 28.1 ^{o}C

CALCIUM
>25mg/L preferred

OPPORTUNITY FOR TRANSPORT
Can live several days out of water

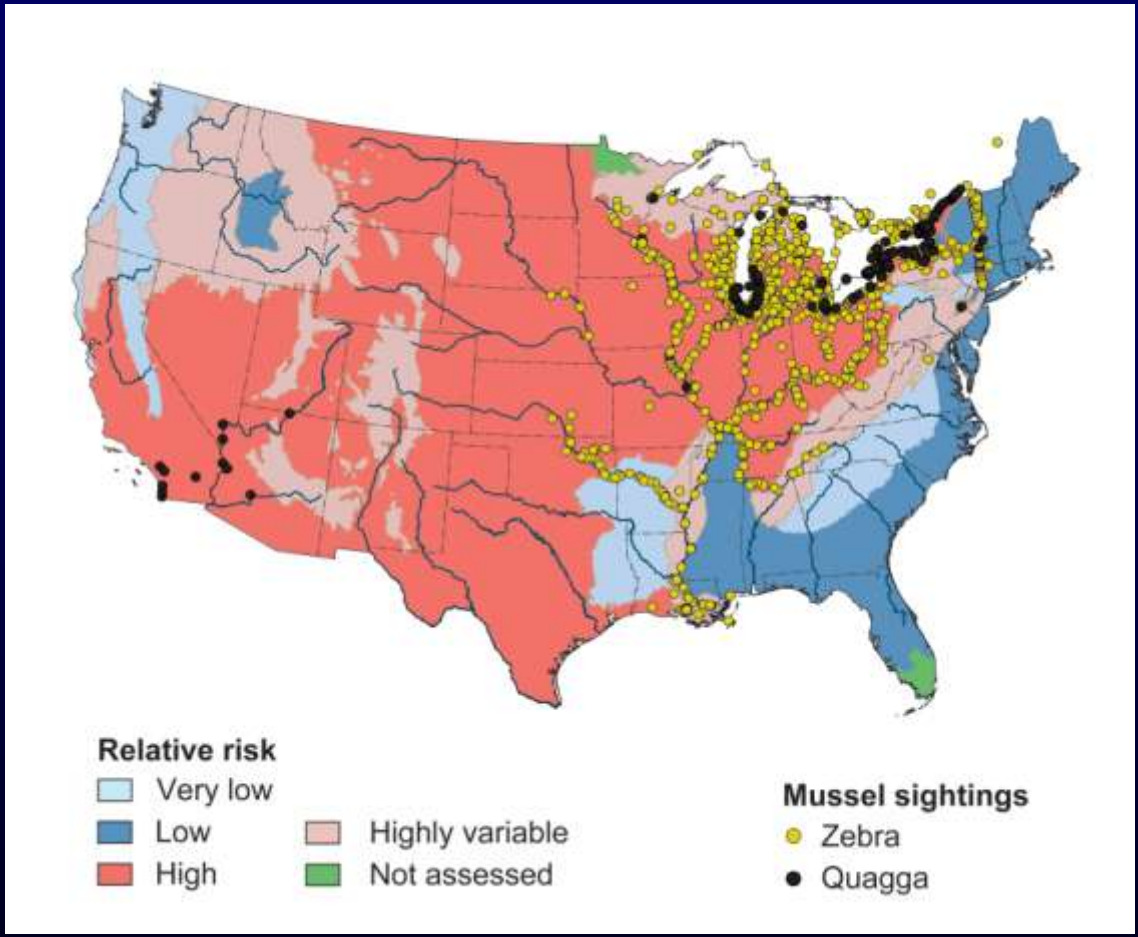
RISK BASED ON CALCIUM

Based on Levels > 28 mg per L H_20

% of US at Risk	Area	Calcium
60%	Plains, Southwest	28+ mg/L
21%	New England, Southeast, western pacific NW	12-20 mg/L
19%		Variable

Oregon State University Study

RISK BASED ON CALCIUM



PREVENTION & CONTROL

- Detect new invasions

Monitoring programs

Indirect (e.g. boat inspections, water quality monitoring)

Direct (e.g. divers)

Inter-agency coordination

Public education programs

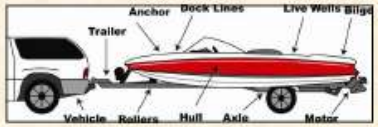
- Respond to and minimize impacts of new invasions
- Provide timely and accurate information
- Keep costs commensurate with values at risk
- Prevent introduction and further spread

PREVENT FURTHER SPREAD

- **Quarantine limits**
  - E..g. California – 10 day quarantine limit
- **Individual transfer reduction practices**
  - Inspect all exposed surfaces (vehicle, trailer, anchor, dock lines, live wells, bilge, motor, hull, trailer axle and rollers). Small mussels feel like sandpaper and are invisible to the eye.
  - Wash the hull of each watercraft thoroughly (steam clean if possible).
  - Remove all debris, plant and animal material.
  - Drain all water and dry all areas.
  - Drain and dry the lower outboard unit.
  - Clean and dry all live-wells.
  - Empty and dry any buckets.
  - Dispose of all bait in the trash.
  - Wait five days and keep watercraft dry between launches into different fresh waters.

PREVENT FURTHER SPREAD

Before Launching…
Before Leaving…
Inspect Everything!



Don't Move A Mussel
Follow These Simple Steps:

- REMOVE any visible mud, plants, fish or other animals before transporting equipment
- ELIMINATE all water from your boat and equipment before moving anywhere
- CLEAN AND DRY everything that came into contact with water (including boats, trailers, equipment, clothing, dogs, etc.)
- NEVER release plants, fish or other animals into a body of water unless they came from that same body of water

CAUTION

Federal law prohibits the transportation or importation of mussels and other injurious wildlife across state lines.
Violators face a penalty of up to $10,000 and six months in prison for each offense.

Quagga and zebra mussels are invasive freshwater mollusks (bivavles) that infest waters in large numbers, attaching to a variety of surfaces. These mussels are a nuisance for anglers and boaters. They clog water pipes and intake valves and cause drastic changes to the environments they invade.

Report any sightings of zebra or quagga mussels to the National Hotline:

1-877-STOP-ANS

1-877-786-7267

Photo Credits: Dave Britton, USFWS and USGS

U.S. Fish & Wildlife Service

Don't Move A Mussel!

STOP AQUATIC HITCHHIKERS!